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The Effect of Incumbent Bidding in Set-Aside Auctions: An Analysis of Prices in the Closed and Open Segments of FCC Auction 35

Peter Cramton
University of Maryland

Allan T. Ingraham
Criterion Auctions

Hal J. Singer
Criterion Economics, L.L.C.

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This paper examines the impact of an incumbent carrier's participation in two simultaneously conducted auctions: one set-aside for non-incumbents and one open to all carriers. This paper estimates the extent to which prices in the closed auction were inflated by the participation of incumbents. This paper also estimates what prices would have been in the open auction had incumbents been excluded from bidding in the closed. It is found that an incumbent's participation in the closed auction through a front, Alaska Native, enabled it to win more licenses at lower prices in FCC Auction 35. In contrast, non-incumbents won fewer licenses and paid more for what they won. The econometric techniques employed here to estimate prices in a "but for" world could be replicated in future damage analysis. Finally, this paper suggests an alternative method of screening bidders seeking access to set-aside auctions that would be consistent with the FCC's goal of promoting competition in the wireless industry.

1. INTRODUCTION

The Federal Communications Commission's (FCC's) re-auction of the C- and F-block licenses (Auction 35) represents a rare natural experiment that economists, and game-theorists in particular, can analyze. Beginning in December 2000, the FCC conducted two simultaneous auctions of largely substitutable goods—radio spectrum licenses covering similar U.S. territories. The FCC first auctioned the majority of those licenses, commonly known as the "NextWave licenses," in 1996, but reclaimed the licenses after NextWave and other wireless operators failed to meet their payment obligations from the prior auctions.[1] This new auction was conducted while the FCC and NextWave were in litigation over the license reclamation.

NextWave was one of the first firms to take advantage of the FCC's set-aside program—the original FCC auction in which NextWave obtained the licenses was reserved for small

entrepreneurial firms, called "designated entities" (DEs). To encourage entry of new wireless operators in 2000, the FCC again reserved certain portions of the spectrum (the "closed" auction) for entrepreneurial firms. In particular, the FCC prevented the participation of any firm in the closed auction that was "controlled" by a firm with assets in excess of $500 million or annual revenues in excess of $125 million (FCC Notice, October 5, 2000). This control standard was intended to promote diversity among wireless carriers and competition after the auction, while allowing small carriers to gain improved access to investment capital from larger telecommunications firms. However, under this control standard, certain incumbent carriers gained access to the closed auction by creating front companies. For example, AT&T Wireless, a firm with assets of $43.0 billion (86 times the FCC's limit) and operating revenues of $6.6 billion (53 times the FCC's limit) as of June 2001,[2] gained access to the closed auction through the creation of a bidding front under the name "Alaska Native."[3] According to Alaska Native's bidding application filed at the FCC in November 2000, AT&T Wireless owned 38.2 percent of the equity of Alaska Native plus debt that was convertible to another 41.2 percent of the company's equity.[4] Alaska Native was the dominant bidder in the closed auction. It won approximately 36 percent of the set-aside licenses on a population-weighted basis, and approximately 50 percent of the set-aside licenses on a value-weighted basis.[5]

However, despite winning the auction, many high bidders did not immediately receive licenses because the NextWave litigation was ongoing. On August 12, 2002, a group of scholars specializing in telecommunications wrote an open letter to FCC Chairman Michael K. Powell, contesting the binding nature of the auction bids. Despite the fact that FCC could not deliver the purchased spectrum, the winning bidders had to treat the obligations as contingent liabilities, raising the carriers' costs of capital and impairing credit ratings. The writers therefore advised the FCC to, "cancel bids made in, or permit winning bidders to opt out of, Auction 35."

By December 2002, many months had passed since the June 2001 D.C. Circuit Court of Appeals decision which ruled in favor of NextWave, and the Supreme Court was expected to announce their decision on the appeal of the Circuit's decision. Verizon pushed a multi-front litigation and legislation strategy to be released from the auction bids, which culminated in the FCC offering an Opt Out plan for all Auction 35 winners. Then, in January 2003, the Supreme Court rejected the FCC's reclamation of the licenses, ruling that while a company is reorganizing under bankruptcy protection, as was NextWave, federal bankruptcy law protects it from dismemberment by regulatory agencies, just as federal bankruptcy law protects a bankrupt company from ordinary creditors. NextWave eventually sold all their licenses in April 2005 to Verizon for $3 billion. Although bids for the majority of licenses let at Auction 35 were eventually cancelled, an analysis of those bids is still valid since those bids represent intent by wireless carriers to lease that spectrum at the associated bid prices. Furthermore, an analysis of Auction 35 bidding is useful in avoiding future problems with the DE program.

In the Advanced Wireless Services (AWS) auction that concluded on September 18, 2006, the FCC moved to remedy past failures of the designated entity program (DE program). In particular, statements by Commissioners Michael J. Copps in response to an Order on Reconsideration for Service Rules for AWS spectrum in the 1.7 GHz and 2.1 GHz Bands indicated the FCC would move to ensure that DE program was not exploited by large wireless carriers. Copps stated, "The DE program is designed to create opportunities for smaller carriers to obtain the spectrum resources needed to bring new services to consumers... Some entities cast themselves as small companies to qualify for auction discounts, having already entered into agreements to lease the spectrum rights they win to industry giants that themselves do not qualify for the discount."

These comments, which followed the AWS-1 Order on Reconsideration, echoed the twin regulatory goals of providing additional opportunities for smaller and rural wireless carriers and enhancing flexibility for potential licensees. The Small Entity Compliance Guide for the first AWS auction, which the FCC published on August 9, 2006, laid out the key changes that were subsequently made:

> The new rules both limit the award of designated entity benefits if any applicant or licensee has a "material relationship" created by certain agreements with one or more entities for the lease or resale of its spectrum capacity, and set out new standards for the payment of unjust enrichment *See* 47 C.F.R. §§ 1.2110(b)(3)(iv)(A) – (B) (designated entities) and 1.2111 (unjust enrichment).

Under these amended rules, larger companies have a more difficult time creating fronts to take part in set-aside auctions.

The changes were also interpreted by Copps, who stated on April 25, 2006, "I am pleased that by strengthening our unjust enrichment rules we take away the incentives for speculators to try to masquerade as legitimate DEs. Under our new rules, bidders who benefit from the 25 percent discount must forfeit that discount if they then turn around and sell some or all of their rights to someone else… I am also pleased that we commit to thoroughly review the application and all relevant documents for each and every winning bidder claiming DE status. Additionally, we pledge to audit every DE at least once during the initial license term."

Ayres and Cramton (1996) demonstrate how set-asides and bidding credits impact competition and prices in auctions. If only weaker bidders (non-incumbents) can bid on the set-aside licenses, the impact of the set-aside auction is to lower prices for the weaker bidders and raise prices for the stronger bidders (incumbents). This creates an incentive for incumbents to participate in the set-aside (closed) auction through a front.

Csirik (2002) finds that revenues from FCC Auction 35 actually rose as a result of the discounted pricing. While some licenses are given out cheap, Csirik argues that the extra that Verizon had to pay as a result was the dominant effect of the discount regime. Furthermore, Csirik finds that overall the DE rules had little effect on the allocation of the biggest licenses between the various participants. In contrast to Csirik, who simulates a world without DE status at all, this paper isolates the effects on the auction of the AT&T's participation through Native Alaska. This paper focuses on outcomes in a world with DE status where DE status cannot be abused, rather than a world completely devoid of DE status.

Bajari and Fox (2005) find that simultaneous ascending auctions for spectrum may allow the market to sort for geographic complementarities. However, the auction design might also result in an inefficient equilibrium, due to implicit collusion. This paper builds on that research by extending analysis to auctions where some participants may not bid on all offerings, and where different participants must bid on the same products at different prices.

This paper attempts to quantify (1) the extent to which prices in the closed auction were inflated by the participation of Alaska Native, and (2) the extent to which prices in the open auction were deflated by the lack of participation by incumbent carriers. It is found that the use of bidding fronts significantly raised prices in the closed auction and significantly lowered prices in the open auction. The paper then reviews the FCC's control standard in Auction 35 and compares it to the control standard used in the first AWS auction, which was completed in September 2006. The study finds that the revised control standard the FCC used during the AWS auction is superior to the control standard used for Auction 35 and is more likely to improve the viability of small and rural wireless carriers to the extent that the FCC believes that small carriers are necessary for a competitive wireless market in the United States.

The paper is organized as follows: Part II provides a brief introduction to the FCC's set-aside program and explains how at least one company exploited the FCC's control standards.[6] In Part III, the results of Auction 35 are summarized. This paper examines the three primary channels in which Alaska Native's participation adversely affected legitimate entrepreneurs in the closed auction. First, Alaska Native obtained licenses that would have otherwise been awarded to entrepreneurs. Second, Alaska Native's bids increased the prices that legitimate entrepreneurs paid for fourteen closed licenses on which Alaska Native was the last bidder to drop out. Third, by driving up prices in first-tier markets, Alaska Native forced value-seeking bidders to turn their attention towards second-tier markets, thereby inflating prices in markets where Alaska Native never submitted a bid.

Part IV simulates prices in a but-for world in which AT&T competed against other incumbent carriers in the open auction. In the closed auction, the demand for spectrum would shift in, thereby generating lower prices. In the open auction, the demand for spectrum would shift out, and higher prices would result. Econometric techniques are used to construct the demand curves in the open and closed auctions under the assumption that AT&T was allowed to bid only in the open auction. The intersection of the supply curve and the reconstructed demand curves represent the predicted prices.

The paper concludes with a brief analysis of the FCC's screening process for entrepreneurs. Although the FCC's definition of control could promote an efficient auction, it could sacrifice diversity and competition after the auction. The FCC's understanding of control is not grounded in economic thought. This paper suggests that sophisticated entities such as NextWave and AT&T render the FCC's affirmative action program ineffective. Moreover, the FCC appears to be incapable (or unwilling) to enforce the Congressional mandate of diversity in the airwaves.

2. THE FCC'S SET-ASIDE PROGRAM AND THE CREATION OF BIDDING FRONTS

In this Part, this paper introduces the FCC's set-aside program in Auction 35 and explains how certain savvy carriers exploited the FCC's affirmative action policies.

2.1. THE PARTITIONING OF THE NEXTWAVE LICENSES BY THE FCC

After years of administering a duopoly in the provision of cellular wireless service, the FCC allocated additional spectrum for personal communications services (PCS) to promote greater competition in the wireless telecommunications industry. Beginning in the mid-1990s, the Commission defined geographic service areas, apportioned six additional licenses per service area, and auctioned those licenses to wireless providers. Those licenses were called the A, B, C, D, E, and F blocks. Notwithstanding the appropriate classification of specialized mobile radio (SMR) providers such as Nextel,[7] under the Commission's licensing arrangement, the maximum number of unique personal communication services (PCS) providers that could obtain spectrum at auction in a given license area was six—that is, one distinct carrier per block. However, PCS licenses can be disaggregated. Were a PCS provider to sell only a portion of its spectrum purchased at auction, the number of providers in a given license area could, in theory, exceed six.

With the passage of the 1994 amendments to the Communications Act of 1934, Congress instructed the Commission to pursue a combination of objectives when allocating spectrum, including a diversity objective. In particular, Congress required the Commission to adopt spectrum allocation procedures that would create opportunities for entrants in the wireless telecommunications industry (H.R. Rep. No. 111, 103d Cong., 1st Sess., at 254 (1993)). The Commission satisfied that mandate, in part, by setting aside the C and F blocks (two of the six blocks of PCS spectrum) for "entrepreneurs." A central purpose of Congress's diversity mandate was to promote greater competition—more carriers in the wireless industry would likely produce lower prices and greater choice for wireless consumers. In addition to using set-asides to promote

competition, the Commission placed restrictions on the total amount of spectrum any single carrier could own in a given license area.

Although competition in the mobile telephony sector has increased significantly since the first broadband PCS auction,[8] roughly 20 percent the available spectrum was tied up in bankruptcy proceedings for several years (FCC's Fifth CMRS Report). In the original C-block auction, the FCC offered to finance the winning bids of entrepreneurs (including NextWave's $4.7 billion of winning bids) with a generous payment schedule. In particular, the FCC allowed winning bidders to make interest-only payments, at a below market interest rate, for six years and payments of principal and interest amortized over the remaining four years of the license term (FCC's Sixth Report, July 18, 1995). Certain bidders exploited the FCC's rules by bidding beyond their means, and then declaring bankruptcy when the payments came due. Therefore, rather than adding a new competitor in the wireless sector, the FCC's policy managed to retain the status quo.

The original C-block auction was an embarrassment for the Commission. Although it felt compelled to devise some form of a diversity program, the Commission would not err in the *same* direction. Auction 35 was a re-auction of spectrum that was previously auctioned in the C- and F-block auctions and subsequently confiscated by the Commission when NextWave and other winning bidders defaulted on payment obligations. In Auction 35, the Commission classified the returned spectrum into large markets (cities with over 2.5 million residents) and small/medium markets (cities with less than 2.5 million residents).[9] In small/medium license areas, the Commission divided the returned spectrum into three parts: two parts for "entrepreneurs" (the "closed" auction) and one part for incumbents (the "open" auction). In large license areas, the Commission set aside only one-third of the spectrum for entrepreneurs.

To determine an applicant's eligibility to bid in the closed auction—that is, to determine whether an applicant was genuinely an "entrepreneur"—the Commission adopted a "controlling interest" standard (FCC Public Notice, September 6, 2000). In particular, the controlling interest standard prohibits any applicant who is controlled by a firm with either significant assets (in excess of $500 million) or significant revenues (in excess of $125 million over the past two years) to bid on closed licenses.[10] The FCC's control standard would presumably prohibit the participation by a large, incumbent carrier such as AT&T.[11]

Although the FCC set aside licenses to "entrepreneurs" who would not have to compete with major phone companies, it revised its rules in August 2000 so that these entrepreneurs could "transfer control of C Block licenses to a non-entrepreneur" (FCC's Sixth Report, August 29, 2000). The Commission rules provided both for findings of *de jure* control—more than 50 percent of an applicant's voting stock is owned by a company—and for findings of *de facto* control (FCC Public Notice, October 5, 2000). Some incumbent wireless carriers such as AT&T exploited the Commission's case-by-case process for determining *de facto* control by forming a new entity, Alaska Native, in which it appeared to own a "non-controlling" interest but in fact it owned a significant share (nearly 80 percent) of the equity. Because the FCC does not, as a matter of policy, screen applicants for eligibility before the auction begins, AT&T effectively gained access to the closed auction. The FCC defends its policy of reviewing eligibility status after the auction ends by suggesting that auctions would never begin if bidders could challenge the eligibility of rivals before the auction.[12]

2.2. The Creation of Alaska Native

In its effort to qualify for designated entity status prior to Auction 35, Alaska Native represented that an entity known as "Council Tree Alaska Native Wireless, L.L.C." owned 60.1 percent of its shares, while an entity known as "AT&T Wireless PCS Interests, L.L.C." owned the

other 38.2 percent. AT&T Wireless Interests, however, held debt issued by Alaska Native that was convertible to equity in Alaska Native at its option. Counting this interest as an equity interest, AT&T Wireless Interests in fact owned 79.4 percent of Alaska Native's shares. AT&T Wireless Interests was wholly owned by an entity known as "AT&T Wireless PCS, LLC," which in turn was wholly owned by AT&T Wireless, at the time the third largest wireless carrier in the country and a subsidiary of AT&T. Thus, through shell corporations, AT&T owned 79.4 percent of Alaska Native's shares. AT&T thus had effective control over ownership of Alaska Native.

With these complex corporate and financial artifices, AT&T gained entry to the closed auction and as discussed later in the paper, even obtained bidding credits reserved for very small businesses participating in the open auction. In the aftermath of Auction 35, AT&T has admitted as much. In a series of securities filings, it has disclosed that its ability to conduct its own wireless telecommunications operations depended significantly on Alaska Native obtaining licenses in the closed auction.[13] According to company officials, "Alaska Native gives us greater flexibility for bidding on the spectrum that is available. Short of buying Alaska Native outright, AT&T could benefit by negotiating a low-cost 'roaming' agreement with the upstart" (Wall Street Journal, January 5, 2000: B1).

Similarly, Council Tree officials have admitted that they had no intention of actually operating a wireless telephone network, and instead view their participation in Alaska Native simply as an "investment." In this regard, they have a right after five years to require that AT&T or its affiliates purchase for as much as $1 billion the equity interests in Alaska Native previously acquired by them for a small fraction of that amount.[14] According to a recent AT&T Wireless securities filing, the acquisition by AT&T Wireless of Council Tree's minority interest may take place even sooner if AT&T Wireless can satisfy rules governing the transferability of wireless telecommunications licenses.[15] As one securities analyst observed shortly after Auction No. 35

had concluded: “The bigger entities put up the capital and the minority entities put up their eligibility” (Bloomberg News, February 27, 2001: 1). Furthermore, AT&T provided $2.6 billion of the $2.9 billion that Alaska Native bid on licenses in Auction 35 representing nearly 90 percent of Alaska Native’s financing.[16]

3. THE RESULTS OF FCC’S AUCTION 35

This paper begins with a review of AT&T’s impact in the closed auction. Next, the results of the open auction are reviewed.

3.1. ALASKA NATIVE’S IMPACT IN THE CLOSED AUCTION

Alaska Native dominated the closed auction, where it bid approximately $2.6 billion to win 29 closed licenses. In the following sections, this paper describes how AT&T’s participation in the closed auction likely harmed legitimate entrepreneurs.

3.1.1. Markets in Which Alaska Native Won the License

Alaska Native won 29 closed licenses that were set apart for small entrepreneurs. Because of the company’s substantial financial assets and its backing by AT&T, Alaska Native continued bidding on those closed licenses well beyond the “reservation price” of the qualified DEs. Consequently, Alaska Native was the dominant bidder in the closed segment of Auction 35. As Table 1 shows, Alaska Native won 29 closed licenses covering 60.3 million people.[17] Because the coverage of all licenses in the closed auction was 167.1 million, Alaska Native won approximately 36 percent of the set-aside licenses on a population-weighted basis. Because the total revenues raised in the closed auction were $5.3 billion, Alaska Native won approximately 50 percent of the set-aside licenses on a value-weighted basis (FCC Public Notice, January 19, 2001).

Place Table 1 here

By winning closed licenses specifically set aside for legitimate entrepreneurs, Alaska Native undermined the FCC's diversity objective, which was to allow smaller companies to acquire spectrum and compete against incumbents in the wireless industry.

3.1.2. Markets in Which Alaska Native Was the Last Bidder to Drop Out

The FCC auction continues as long as a bidder is willing to bid higher on one or more licenses. As soon as the price of a license reaches or exceeds the reservation price of one of the two remaining bidders, that bidder drops out and the competition for that license ends. Therefore, the last bidder to end the bidding for a license sets the price of the license. By submitting bids on closed licenses that it eventually does not win, Alaska Native inflated the prices for legitimate entrepreneurs that ultimately won those licenses. Assuming AT&T's presence did not significantly change market structure, if Alaska Native had not participated in the closed auction, the qualified DE with the *second*-highest reservation price would have set the price of the license in each market.

Table 2 illustrates the results for those markets in which Alaska Native was the last bidder to drop out.

Place Table 2 here

As Table 2 shows, Alaska Native set the price in fourteen closed license areas. Alaska Native placed second-to-high bids totaling $296.1 million for licenses in those markets. The table also lists, for each market, the final bid by the last legitimate entrepreneur before Alaska Native to drop out of the auction. Legitimate entrepreneurs placed third-to-high bids totaling $257.7 million

in those license areas. By this measure, Alaska Native's participation in the closed portion of the auction increased prices paid by winning bidders by $38.4 million (equal to $296.1 million less $257.7 million).

3.1.3. Markets in Which Alaska Native Induced a Value-Seeking Firm to Bid in a Second-Tier Market

In addition to increasing directly the prices of closed licenses, Alaska Native's participation in the closed portion of the auction indirectly increased prices for markets in which Alaska Native never bid. In particular, Alaska Native's participation induced some value-seeking firms to abandon their plans to acquire spectrum in first-tier markets of the closed auction and to start bidding in second-tier markets instead. For example, because of the participation of Alaska Native in first-tier markets, value-seeking firms like Leap, Northcoast, and 3DL were forced to refocus their interests in the second-tier closed markets, which, for those bidders, were not as valuable. An analysis of the bidding reveals that Leap diverted its interests toward San Antonio and Austin (away from Dallas and Houston), Columbus (away from Cincinnati), and Providence (away from Boston). Leap would place less value on these second-tier markets either because they have lower population density than Leap's preferred markets, or because they do not fit as well with Leap's current footprint. A press statement from Leap's chief executive officer released shortly after the auction further supports the value-seeking strategy employed by Leap:

> We used the auction as an efficient, selective way to target the right markets at the right price. Because of our disciplined bidding, we achieved the lowest average price per POP among the ten most active bidders in the auction. This supports our goal to be a wireless carrier with one of the most efficient cost structures in the country (PR Newswire, January 26, 2001: 1).

Shortly before the auction ended, a Leap senior vice president suggested that "the company will leave the auction with far less spectrum than it wanted because competition from entrepreneurs backed by big companies has driven up prices" (Wall Street Journal, January 5, 2001: B1).

Similarly, Northcoast Communications did not prefer to bid in second-tier closed markets. Alaska Native's participation in the auction for closed licenses in first-tier markets inflated the prices in those markets and forced Northcoast to redirect its interests to second-tier spectrum. Like Leap, Northcoast followed a value-seeking strategy by trying to acquire first-tier licenses at affordable prices in the closed auction. Northcoast's reluctance to bid in second-tier licenses is evidenced by its late entry in second-tier markets.

Table 3 lists each of the markets in which Northcoast bid, the round in which it placed its first bid, the population of the market, and whether Northcoast ultimately won the license. As Table 3 illustrates, Northcoast placed its initial bid on most second-tier licenses well after round fourteen of the auction.

Place Table 3 here

The mean population of the markets in which Northcoast bid before and after round fourteen are computed. The mean population of the markets in which Northcoast bid by round fourteen were more than *four times* as large as the markets in which Northcoast placed its first bid after round fourteen. The markets in which Northcoast bid before round fourteen were classified as first tier markets by the FCC (population larger than 2.5 million), while the markets in which the company expressed interest after round fourteen were second-tier markets (population less than 2.5 million) (FCC Public Notice, September 6, 2000).[17] Such evidence suggests that Northcoast bid for second-tier licenses only after its most desired market became too expensive.

The effect of a shift in demand by value-seeking firms such as Leap and Northcoast toward second-tier properties was an increase in the price of second-tier markets. Hence, even legitimate entrepreneurs that did not bid directly against Alaska Native felt its presence.

3.2. Results of the Open Auction

The open auction was conducted at the same time as the closed auction. Bidders that qualified as small firms received a 25 percent bidding credit on licenses in the open auction—that is, a bid of $100 was interpreted as commitment by a small firm to pay only $75 conditional on winning the license. The effect of such a bidding credit was to permit qualifying firms to switch between the open and closed auction whenever the ratio of prices in the closed auction to the prices in the open auction exceeded 0.75.

The average price per MHzPop in the open auction was $4.96, compared to the average price of $3.12 in the closed auction. Verizon Wireless, which did not use a front to gain access to the closed auction, won roughly half (113 of 252) of the open licenses. On a population-weighted basis, Verizon won 65.2 percent of the open licenses. On a value-weighted basis, Verizon won 76.2 percent of the open licenses (Verizon submitted high bids of $8.78 billion).

The most intense competition in the open auction occurred in the New York Basic Trading Area (BTA). Verizon won each of the two 10 MHz licenses covering the New York BTA for a combined price of $4.1 billion. Had Verizon allowed the next-highest bidder to acquire one of the two open licenses, the final price per license would have been significantly lower.[18]

4. ESTIMATING THE BUT-FOR PRICES IN THE CLOSED AUCTION

As stated above, Alaska Native paid $2.6 billion to win 29 closed licenses that represented 36 percent of the population-weighted spectrum made available in the entire closed auction, and 50 percent of that spectrum on a dollar-weighted basis. Below, the process of bidding in an FCC

spectrum auction is explained, and then the concept of supply and demand within the concept of the FCC's spectrum auction formation is reviewed. This paper then introduces a supply and demand model that defined the market equilibrium in the closed auction, and estimates that model to determine the effect of AT&T's bidding on the closed licenses on the average prices paid the closed licenses.

4.1. BIDDING IN AN FCC SPECTRUM AUCTION

The FCC's spectrum auctions are multiple round ascending price auctions.[19] In any given auction, the FCC lets a specific number of spectrum licenses for sale and establishes minimum bid prices (reserve prices) for each license. Bidding occurs during rounds. At the start of an auction, rounds may last as long as two hours. Toward the end of the auction, when very few bids are submitted, rounds may be as short as 5 or 10 minutes.

At the start of a round, the FCC announces the current price of a license and the minimum price at which it will accept a new bid for that license in the subsequent round. A valid bid must be at least as high as that minimum price. In most auctions, bidders may exceed that minimum price, but only by bidding increment amounts stipulated by the FCC. For example if the current price of a 20 MHz license in New York is $50 million and the bid increment is $5 million, then the minimum acceptable bid in the next round is $55 million. However, a bidder could, if it desired, submit a bid of $50 million + I x $5 million, where I is an integer typically between 1 and 9.

Currently, the FCC specifies bid increments as a percentage of the current price of a license. Increments typically range between 20 percent and 5 percent of the current price of the license. The percent increment depends on largely on the number of new bids submitted for the license in the prior round. The more bids there were in the prior round, the higher the increment will be. Therefore, increments are typically 20 percent near the start of the auction, when bidding is

intense, and gradually decrease to 5 percent as the auction ends. With the exception of the very last round of the auction, in which no new bids are submitted, the average price of spectrum is, by construct, higher than that of the previous round. Hence, the name *ascending* price auction accurately describes an FCC spectrum auction.

To be eligible to bid in an FCC auction, a bidder must make an initial down payment. The size of a bidder's down payment determines the maximum quantity of spectrum, expressed in MHz-pop, it can bid on at auction. Small regional operators who are interested only in a few licenses typically make small initial payments to bid only on those few licenses. National carriers typically make large payments that allow them to bid simultaneously on all licenses at auction, so long as those licenses are not set-aside for small carriers.

Each bidder has a specific demand for spectrum. The auction ends when prices rise high enough so that no new bids are submitted. When this occurs, the sum of all bidders' individual quantities demanded for spectrum will equal the fixed quantity of spectrum that the FCC has let at auction. Put simply, the market clears when supply equals demand.

This paper focuses on the effect of AT&T's participation through Native Alaska even though other large firms used fronts because Native Alaska dominated the closed auction for spectrum. Cingular Wireless bid through Salmon, which enjoyed a 25 percent discount in the open auction as well as access to the closed auction. Voicestream bid through Cook Inlet VS, which had no open auction discount, but still did have access to the closed auction. Verizon did not bid through any smaller front. This may have been due to the unclear legal status of the front setups at the time, or more likely the falling marginal returns on fronting after another large market player has done so. If Verizon entered through a front, they would still compete with other large firms in the closed auction; meanwhile, Verizon could take advantage of lower prices in the open auction with AT&T's absence.

4.2. CALCULATING THE MARKET DEMAND FOR CLOSED SPECTRUM

Let Q_r^c denote the quantity demanded of all bidders in the closed auction in round *r*. Quantity demanded in a given round is a function of the price of closed spectrum in that round, p_r^c. As round numbers rise, and license prices increase, the model can trace out the market demand curve for closed spectrum:

[1] $Q^c = f(p^c)$.

To estimate the market demand for the closed licenses, the model first retrieves the market quantity demanded for closed spectrum, measured in MHzPop,[20] in each round of the auction. The model adds the MHzPop from all new bids submitted in round *r* to MHzPop from all standing high bids from round *r*–1, and then subtracts out the MHzPop of any bidder who raised its own high bid in round *r*. The model then calculates the price in dollars per MHzPop on all standing high bids in round *r* to get the associated price. This procedure yields a market demand curve for spectrum in the closed licenses. Specifically, the model performs the following calculation for each auction round:

[2] $Q_r^c = N_r^c + H_{r-1}^c - \hat{H}_r^c$,

where N_r^c represents new bids submitted in round *r*, H_{r-1}^c is the high or "temporary winning bids" at the end of round $r-1$, and $\hat{H}_r^c$ represents high bids in round *r* in which the "temporary winning bidder" increased its own high bid from round $r-1$. N_r^c is obviously a valid component of round *r* demand, because those bids were submitted in that round. High bids from the prior round are also part of *this round's* demand, because a bidders new bids and standing high bids are not allowed to exceed its total eligibility in any given round. Finally, if a bidder increased its own

high bid, the spectrum from that license would be included in both new bids, N_r^c, and standing high bids, H_{r-1}^c. Therefore, $\hat{H}_r^c$ must be subtracted to avoid double-counting.

4.3. Calculating AT&T's Demand for Closed Spectrum

This above analysis is repeated, but only for Alaska Native, to obtain AT&T's demand for closed spectrum, which is denoted $q_{ATT,r}^c$. Specifically, the model takes the MHzPop that AT&T bid in round *r*, and adds its standing high bids in MHzPop from round *r*–1. The model then subtracts off any intersection that occurs when a high bid is raised,[21] and matches these quantities to the price variable discussed above for each of the 100 auction rounds.[22] Matching AT&T's quantity demanded for closed spectrum against prices for that spectrum yields AT&T's demand for closed spectrum:

[3] $q_{ATT}^c = f_{ATT}(p^c)$.

4.4. Market Equilibrium and AT&T's Impact in the Closed Auction

There was a fixed supply curve of spectrum in both the open and closed auctions. In the closed auction, 1.7 billion MHzPop of spectrum was let at auction. Thus, the market supply of closed spectrum was given by the following, perfectly inelastic, supply curve:

[4] $Q_S^c = 1.7\ billion$.

With AT&T bidding in the closed, the market-clearing price was roughly $3.12 per MHzPop, which was found by setting Q^c equal to 1.7 billion. Specifically, supply in Equation [4] was equated with demand from Equation [1]. The two curves intersect at a price of $3.12 per MhzPop.

The market demand curve is the sum of the individual bidder's demands. Therefore, to calculate AT&T's impact on prices in the closed auction, AT&T's quantity demanded for closed spectrum is subtracted in each auction round from the market demand in the closed auction. In particular,

[5] $Q_r^{*c} = Q_r^c - q_{ATT,r}^c$,

where Q_r^{*c} is the residual quantity demanded for closed spectrum in round *r*. The residual market demand for closed spectrum is given by:

[6] $Q^{*c} = Q^*(p^c)$,

which is the graphing of the residual quantity demanded for closed licenses in round *r* against the price for the closed spectrum in round *r*. The model then looks along this residual market demand curve to find the price at which total market demand was roughly equal to the market supply of 1.7 billion MHzPop. Formally, the model solves:

[7] $1.7\ billion = Q^*(p^c)$.

Solving for price yields $1.97 per MHzPop. Therefore, AT&T's presence in the closed auctions caused an increase in price of roughly $1.15 per MHzPop, or 58 percent.

5. ESTIMATING THE BUT-FOR PRICES IN THE OPEN AUCTION

5.1. METHODOLOGY

What AT&T would have paid in the open if it was not allowed to create a bidding front in the closed is now estimated. First, AT&T's total demand for spectrum—that is, what Alaska Native bid in MHzPop in both the open and the closed for a given round is determined. Above, AT&T's demand for spectrum in the closed was found. To determine AT&T's total demand for spectrum, AT&T's demand for open spectrum is horizontally added to AT&T's demand for closed spectrum. In particular, let $q_{ATT,r}^o$ denote AT&T's quantity demanded for open spectrum in round *r*. That quantity was bid at a price of p_r^o. Matching those price-quantity combinations yields AT&T's demand for spectrum in the open segment of the auction:

[8] $q_{ATT}^o = q_{ATT}(p^o)$.

Next, AT&T's total demand for spectrum as the horizontal summation of quantity in the open and the closed segment of the auction is determined, and matched against the average price of spectrum in both auctions. Thus, AT&T's total demand for spectrum in Auction 35 is

[9] $q^o_{ATT} + q^c_{ATT} = q_{ATT} = q_{ATT}(p)$,

where q_{ATT} is AT&T's total quantity demanded, and *p* is the average price of spectrum.

To transfer AT&T's total demand into the open auction, first AT&T's demand curve for spectrum is estimated. Then what AT&T's quantity demanded of spectrum would have been at the open prices is predicted. Formally, econometric techniques are used to estimate $q_{ATT}(p)$. The open prices are inserted into this estimate, $\hat{q}_{ATT}(p)$. The following is calculated:

[10] $\hat{q}_{ATT} = \hat{q}^o_{ATT} = \hat{q}_{ATT}(p^o)$,

where $\hat{q}_{ATT}$ is AT&T's total demand for spectrum *had it only been allowed to bid in the open segment of Auction 35.*

Next, Alaska Native's actual bids (in MHzPop) in the open are subtracted from the market demand curve in the open, and then $\hat{q}_{ATT}$ is added back to the appropriate open prices. This yields an estimate of the demand for spectrum in the open that would have been realized if AT&T had been precluded from bidding for the closed licenses. Formally, let Q^o_r denote total quantity demanded in the open segment of Auction 35 in round *r.* As in the closed segment, demand is a function of price:

[11] $Q^o = Q^o(p^o)$.

For each round, *r*, AT&T's quantity demanded in the open is subtracted, and AT&T's estimated total demand for spectrum is added back. Thus, $\hat{Q}^o_r$, the estimated total demand for open spectrum in round *r* had AT&T been precluded from bidding in the closed, is calculated as

[12] $$Q_r^o - q_{ATT,r}^o + \hat{q}_{ATT,r}^o = \hat{Q}_r^o .$$

Performing this calculation for all rounds, the demand curve for open spectrum is estimated as

[13] $$Q^o(p^o) - q_{ATT}(p^o) + \hat{q}_{ATT}(p^o) = \hat{Q}^o(p^o) = \hat{Q}^o .$$

With this equation, the price that would have occurred at the fixed supply of 2.32 billion MHzPop in the open portion of the auction is estimated. Further, the price obtained in this last step is used to predict the quantity of spectrum that AT&T would have won in the open, given their demand for total spectrum, and its savings from having bid in the closed is calculated.

5.2. Estimating AT&T's Demand for Spectrum

First, AT&T's demand for spectrum in each round of the auction, at the average price per MHzPop in the entire auction, is determined.[23] The price for spectrum ranged from $0.10 per MHzPop in round 1, and increased steadily to over $4.18 per MHzPop by round 100. AT&T's total quantity demanded for spectrum ranged from a maximum of 34.3 billion MHzPop in round 4 to 648 million MHzPop in round 98. At auction's end, AT&T won a total of 649 million MHzPop of spectrum. Note that this demand curve is not perfectly downward sloping—the FCC's activity rules required a bidder to be active on 80 percent to 99 percent of its total demand during different stages of the auction. Thus, a bidder can, to a limited extent, expand the MHzPop on which it bids as prices rise. For this reason, the demand curves are smoothed, and in so doing, the fact that if bidders were active on 8 billion MHzPop at a price of $2.50 per MHzPop is acknowledged at higher price points in the market demand curve. So, the market would demand *no more than* 8 billion MHzPop at a price greater than $2.50.[24] Alternatively, AT&T's demand could be smoothed by filling back smaller quantities demanded with any larger quantities that occurred in later rounds, thus creating a demand curve that is a true step function. This would serve as an upper bound of AT&T's demand in any round of the auction, and might lead the model to overstate the savings that AT&T garnered from bidding in the closed. For this reason

analysis is conducted using the smoothed demand curves as well. Footnotes will reference these results in later sections of the paper.

An ordinary least squares is now run on AT&T's total demand in Auction 35. The model uses a log-linear model—namely, prices are regressed on the log of quantity, for the sample of 100 auction rounds. Thus, the estimates of α and β are sought in the regression equation

[14] $logATTQ_r = \alpha + \beta Price_r + \varepsilon_r$.

In the above regression equation, *r* is an index for the auction round, and ε is a stochastic shock that is assumed to be of constant variance and zero mean across all auction rounds.

Variable definitions are presented immediately below, and summary statistics for those variables are presented in Table 4.

- *ATTQ* = Total quantity demanded for AT&T, smoothed.
- *LogATTQ* = Natural log of AT&T's smoothed quantity demanded
- *Open-ATT* = Smoothed, log of quantity demanded in the open, less AT&T's demand via Alaska Native
- *Price* = Average price paid for all spectrum at auction
- *PriceOpen* = Price paid for the open licenses

Place Table 4 here

Applying OLS to the above regression variables to estimate AT&T's demand curve for spectrum in Auction 35, the following regression results presented in Equation 15 below are obtained. Standard errors are reported in parentheses below the regression parameters.

[15] $$\underset{(0.028)\ \ (0.008)}{logATTQ = 21.89 - 0.38Price}$$

The coefficient on price in Equation 15 is interpreted to mean that a $1 increase in price will lead to a 38 percent decrease in the total quantity of spectrum that AT&T demands. The regression parameter on *Price* is statistically significant at the ninety-nine percent level. Also, the R^2 for the regression is 96 percent. The right hand side variable therefore explains most of the variation in the dependent variable—an attractive characteristic because the regression will be used for prediction purposes.

5.3. Predicting AT&T's Demand, and Total Demand, in the Open

The parameter estimates from (1) are used to predict AT&T's quantity demanded in each round of the open segment of the auction. This prediction is outlined by equation 10 above. In particular, the regression parameters from equation 15 are applied to the round-by-round price vector for the *open segment of the auction*. Performing this prediction yields $\overline{logATTOpen}$.[25] Using this predicted demand curve for AT&T bidding in the open, had AT&T been precluded from bidding in the closed, total demand in the open is estimated to be

[16] $$\overline{Open} = (Open - ATT) + e^{\overline{logATTOpen}}.$$

5.4. Estimating the Results if AT&T Only Could Bid in the Open

The next step in the analysis is to estimate the demand curve in the open, using the calculation of quantity demanded in the open from equation 16 above. To do this, OLS is used to regress the calculation of total demand in the open, $\overline{Open}$, on round-by-round prices in the open segment of the auction. Running this regression yields the following:

[17] $$\underset{(0.018)\quad (0.005)}{\overline{Open} = 23.46 - .352OpenPrice}.$$

The regression in equation 17 has an R^2 of 0.98, meaning that the regression explains 98 percent of the variation in the dependent variable. Further, the standard error of the prediction—that is, the errors between the fitted values on the regression line and the left hand side observations—is small.[26] Given equation 17, the clearing price in the open auction is predicted, knowing that approximately 2.32 billion MHzPop was let at auction.[27] In log form, the clearing price of $5.39 occurs at a logged quantity of 21.595. This means that prices for the open licenses were suppressed by approximately 53 cents, because AT&T was allowed to bid on the closed licenses through Alaska Native.

To complete this section of the analysis, a price of $5.39 is substituted into AT&T's demand for spectrum, given by equation 15, to determine the spectrum AT&T would have had it been precluded from bidding in the closed. This quantity is determined to be 403.1 million MHzPop.

5.5. AT&T'S SAVINGS FROM BIDDING IN THE CLOSED

By bidding in the closed, there are two effects that allowed AT&T to derive a surplus, beyond what it would have enjoyed, had it only bid on the open licenses. The first effect is that it won a larger quantity of spectrum than it would have otherwise. In particular, AT&T won 649 million MHzPop in Auction 35, whereas it would have won 403 million MHzPop had it only been allowed to bid in the open segment of Auction 35. Because AT&T's returns model for spectrum is private, the benefits to AT&T of owning the additional quantity cannot be discerned. What is known, however, is that AT&T paid, on average $4.46 per MHzPop for all spectrum (open and closed) that it won at Auction 35. If AT&T had only been allowed to bid in the open, the clearing price in that auction would have been $5.39 per MHzPop. Thus, AT&T would have paid roughly this amount for spectrum, on average, in the open portion of the auction. Thus, AT&T saved, on average, $5.39 - $4.46 = $0.93 per MHzPop on 403 million MHzPop of spectrum, a savings of $374.8 million.[28]

5.6. The Global Effect on the Open and Closed Auctions from AT&T's Bidding Front

Because AT&T saved money through its bidding front on the first 403 million MhzPop of spectrum it purchased, one could infer that downward pressure was placed on the *combined* prices for the open and closed. However, AT&T's competition in the closed segment allowed it to purchase 649 million MhzPop of spectrum. Consequently, the price of the remaining spectrum that AT&T purchased in the closed, was likely more expensive than it would have been absent AT&T. Further analysis is therefore required to determine the global affect of AT&T's bidding front on auction prices.

Restricting AT&T from bidding in the closed segment of the auction is analogous to subtracting AT&T's demand for closed spectrum from the total demand for closed spectrum in each round of the auction. According to the estimates, all closed competitors, less AT&T, would have demanded 1.7 billion MhzPop at a price of $2.51 per MhzPop, which occurred by round 32 of the auction. Therefore, AT&T's participation in the closed increased prices by $3.13 - $2.51 = $0.62 per MhzPop, which fetched an additional $1.042 billion from the closed spectrum. However, AT&T's participation in the closed reduced prices in the open. As explained above, prices in the open would have been $5.39 had AT&T not bid in the closed. Prices in the open were $4.96 indicating that $0.43 of revenue was lost on 2.8 billion MhzPop of spectrum. Therefore, revenue in the open auction was reduced by $981 million. Hence, total auction revenue increased by approximately $61 million ($1.04 billion - $981 million). Consequently, the *global* revenue effect of AT&T's bidding in the closed auction was small, given the total financial size of the auction.

6. CONCLUSION

If the FCC were attempting to maximize the welfare of consumers of telecommunications services, it would choose an auction design to ensure (1) that the winning bidders placed the greatest value on the spectrum ("efficiency objective") and (2) that there were a sufficient number of winning bidders to yield competitive outcomes ("competition objective"). The diversity mandate imposed by Congress, however, constrained the FCC in its formulation. In particular, the diversity constraint required that the FCC take steps to insure a diversity of spectrum winners, even if the spectrum is most highly valued by the large incumbent carriers.

The FCC decided that, after the bankruptcies in prior set-aside auctions, small firms required additional investment capital to survive in the wireless industry. But that capital did not need to come from incumbent wireless operators. In particular, if additional wireless carriers could survive in the existing market, those carriers would receive backing in a financial market without liquidity constraints. However, the FCC's control standard allowed small firms to act as fronts for large wireless incumbents, thereby defeating the diversity constraint, because the licensees were neither different nor small. Thus, the FCC's standard likely met its efficiency criteria, but it did so at the expense of its competition objective and diversity requirements.

To an economist, the definition of control the FCC used in Auction 35—that is, ownership of a simple majority of voting shares or any other factors listed in its definition of *de facto* control—is of only limited value. But economic control comes from controlling a “critical” share of the affiliate’s net cash flows. Because AT&T owns 80 percent of Alaska Native’s net cash flows, AT&T likely has sufficient ownership of Alaska Native to possess economic control. The relevant question from a competition perspective is whether an incumbent (such as AT&T) owns a sufficient amount of an entrant’s (such as Alaska Native’s) equity such that it would be induced

to raise prices in a unilateral fashion (relative to an outcome in which some third party obtained the new license).

The above test makes clear that neither voting control nor any variables that measure direct management control are sufficient to capture the concept of "control" as that term is normally understood by economists or the Commission. For example, neither "50 percent of the board of directors or management committee" nor the "authority to appoint, promote, demote, and fire senior executives" will affect the incumbent's primary economic objective—to maximize the sum of its own profits plus its pro-rata share of the profits of its front—when the incumbent sets its price (Auction 35 Public Notice). The Commission's test for *de facto* control instead contemplated full consideration of a broad range of control indicators, and under that test, a finding of control would clearly be compelled in this case.

In its second report and order in the matter of the implementation of the Commercial Spectrum Enhancement Act and modernization of the Commission's Competitive Bidding Rules and Procedures, the FCC revamped its definition of control. The FCC first eliminated the ability of any firm with "impermissable material relationships" from receiving designated entity benefits. The FCC defined such a relationship as one in which a licensee "has agreements with one or more other entities for the lease (under either spectrum manager or de facto transfer leasing arrangements) or resale (including under a wholesale arrangement) of, on a cumulative basis, more than 50 percent of its spectrum capacity of any individual license."[31] Furthermore, the FCC defined an "attributable material relationship" as one where the designated entity in question leased or resold, on a cumulative basis, more than 25 percent of the capacity for any one license. Therefore, the FCC's revised standards base control on ownership share of the essential input of production in question (spectrum), and should therefore be superior to those in force during Auction 35.

Although the FCC's current implementation of its designated entity program is likely an improvement upon its prior standard of control, the FCC should continue to monitor the relationship between designated entities and incumbent wireless carriers or scrap the program entirely. The prior policy, which resembled an affirmative action program on the surface but actually maintained the status quo, generated at least two types of harm. First, legitimate entrepreneurs who had little chance of winning licenses wasted scarce resources in preparing business plans and raising capital. Second, incumbent carriers wasted resources in creating front organizations to obtain set-aside spectrum. When AT&T exercises its option to acquire the next 40 percent of Alaska Native, the minority shareholders that went along with the scam will be unjustly enriched. The transactions costs of creating fronts are a pure waste of resources. Consequently, the FCC's improved control standard should produce a more efficient allocation of resources in the marketplace and should better fulfill the mandate set by Congress by helping true entrants instead of further entrenching current incumbents.

Footnotes

1. In June 2001, the U.S. Court of Appeals for the District of Columbia concluded that "the Commission violated the provision of the bankruptcy code that prohibits governmental entities from revoking debtors' licenses solely for failure to pay debts dischargeable in bankruptcy," thereby invalidating the results of Auction 35 (NextWave Personal Communications v. Federal Communications Commission, 254 F.3d 130 (D.C. Cir., June 22, 2001)). One day after the Court of Appeal's decision in favor of NextWave, the FCC issued a press release stating its intention to pursue NextWave at the Supreme Court (FCC News Release, August 31, 2002). By the summer of 2002, after months of settlement efforts failed, the FCC refused to cancel the reauction results, even though it had no spectrum to give the winners (Wall Street Journal, September 24, 2001: 1). In September 2002, the FCC reversed course, and determined that the public interest would be best served by allowing the winning bidders to opt out of the auction (Wall Street Journal, September 12, 2002: 1).

2. AT&T WIRELESS SERVICES INC., S.E.C. FORM 10-Q at 4 (filed Aug. 14, 2001).

3. Salmon PCS, LLC, a bidding front set up by Cingular Wireless, also bid in Auction 35. However, Salmon focused its bidding on the open segment of the auction, whereas Alaska Native bid mostly in the closed auction. In particular, Alaska Native spent $2.7 billion for 29 of the closed licenses, and spent only $201 million for 15 open licenses. Salmon won 35 closed licenses and paid $674 million for those licenses, while winning 44 open licenses worth $1.7 billion. Because Alaska Native spent 4 times as much for closed spectrum than did Salmon, the paper focuses the analysis on the impact of Alaska Native's bidding.

4. ALASKA NATIVE WIRELESS L.L.C., F.C.C. FORM 175 APPLICATION, Applicant Identity and Ownership Information at 4 (filed Nov. 6, 2000) (AT&T Wireless PCS Interests "holds 39.9 percent of all member interests in ANW. Under Section 1.2110(c)(2)(ii)(A) of the Commission's

Rules, therefore, AWPI would be considered to hold not more than 80 percent of all member interests on a fully-diluted basis…").

5. Auction results are available for download at the FCC's web site <http://www.fcc.gov/wtb/auctions/35/charts/35markets.xls>.

6. It is quite possible that other incumbent carriers used fronts to gain access to the closed auction. Because Alaska Native so thoroughly dominated the closed auction, however, the paper focuses on Alaska Native's effect on the results.

7. The Commission has subsequently ruled that Nextel and other SMR providers operate in an antitrust market distinct from the mobile telephony market. At the time of Auction 35, however, SMR spectrum counted against the CSMR spectrum cap. However, it is likely that this is a special case; the FCC explicitly considers SMR to be part of CSMR in the spectrum cap proceeding.

8. As of the summer of 2000, roughly 40 percent of all U.S. wireless telecommunications consumers were served by at least four PCS (non-cellular) providers.9. For a concise review of the FCC's rules and licenses for sale in Auction 35, visit the FCC's Auction 35 web page < http://wireless.fcc.gov/auctions/35/factsheet.html>.

10. *Id.*

11. According to its 10-K filing with the Securities and Exchange Commission in 2000, AT&T reported assets of $169.406 billion at the end of 1999—339 times the $500 million asset threshold allowed by the Commission rules. AT&T also reported operating revenues of $62.4 billion at the end of 1999—499 times the $125 million revenues threshold allowed by the Commission rules. AT&T CORP., S.E.C. FORM 10-K (filed Mar. 27, 2000).

12. The FCC believes that by doing so, it would allow any objecting party to permanently postpone the auction. *See, e.g.*, Allegheny Communications Inc. v. FCC, No. 00-1524 (D.C. Cir. Dec. 11, 2000).

13. AT&T CORP., S.E.C. FORM 10-K405/A at *1 (filed Apr. 17, 2001) ("If the FCC determines that Alaska Native Wireless was not qualified, the FCC could refuse to grant Alaska Native Wireless the closed licenses. If this occurs, it could have a significant adverse impact on AT&T Wireless Group's ability to provide or enhance services in key new and existing markets.").

14. AT&T CORP., S.E.C. FORM 10-K405/A at *1 (filed Apr. 17, 2001) ("…the other owners of Alaska Native Wireless have the right to require us to purchase their equity interests. If this right were exercised five years after license grant, the price could be as much as approximately $950 million and would be payable, at our option, in cash or marketable securities.").

15. *Id.*

16. AT&T WIRELESS SERVICES INC., S.E.C. FORM 10-Q (filed Aug. 14, 2001) ("In January 2001, the auction was completed and ANW was the high bidder on approximately $2.9 billion in licenses. AT&T Wireless Services has committed to fund $2.6 billion to ANW to fund ANW's purchase of licenses.").

17. Population figures are based on 1990 census data.

18. A bidder's reservation price is the highest price that the bidder is willing to pay for a particular license. Notwithstanding other strategic considerations such as reducing demand or pursuing synergies across multiple licenses, a bidder will continue bidding on a license until the price of the license exceeds his reservation price (Milgrom and Weber, 1982:50). Therefore, the bidder with the highest reservation price generally wins the license. By reserving certain licenses

for small entrepreneurs, the FCC sacrificed efficiency (the highest-value bidder would not win the license) for the sake of promoting entry.

19. Salmon PCS reduced activity from two licenses in New York to one license at a price of $511 million for each license, and reduced activity from one license in New York to no licenses in New York at a price of $1.41 billion.

20. For a more thorough review of the rules in FCC spectrum auctions, see Cramton, 1997.

21. MHzPop is the appropriate measure of quantity, because it captures the persons (pops) you can address with useable bandwidth (MHz).

22. Alaska Native raised its own high bid only once. In round 42 Alaska Native raised its own high bid on the C block New York City license.

23. There were in fact 101 auction rounds, the last round containing no new bids. Therefore, the demand curve between round 100 and round 101 is the same mapping of price to quantity, and is superfluous.

24. For this analysis the model uses Alaska Native's demand for AT&T's demand, and excludes bids made by "AT&T Wireless" in the auction. The reason for this exclusion is that AT&T wireless dropped out of the auction in round 32, after bidding on Bismark, ND, Fairbanks, AK, and Walla Walla, WA. Thus, it is clear that AT&T was willing to drop out of the auction, knowing that Alaska Native would win spectrum on its behalf. Therefore, AT&T's sincere demand is represented by Alaska Native's bids.

25. Results are almost identical if one instead analyzes the unsmoothed demands. Notes of these results will be made throughout the remainder of the paper.

26. The mean and standard deviation of the predicted values are 20.36 and 0.54 respectively. The standard errors of the forecast have a mean of 0.11 and a standard deviation of 8.0×10^{4}. In

addition, the minimum and maximum values of these errors are 0.1096 and 0.113 respectively. Thus, it is likely that the prediction of AT&T's full demand for spectrum in the open is accurate.

27. These disturbances have a mean of 0.017, a standard deviation of 0.006, and extreme values of 0.0128 and 0.0349.

28. The exact quantity was 2,321,982,450 MHzPop.

29. This amount likely understates the savings on those 425 million MHzPop, because AT&T tended to bid on, and win, the more attractive licenses at auction. The prices for these licenses were often higher, on a MHzPop basis, than the average price for spectrum at auction. Thus, the price of $5.24 is probably lower than what AT&T would have paid for spectrum had it only been allowed to bid on the open licenses.

30. For a detailed explanation of the *de facto* standard, see the Commission's affiliation rule at 47 C.F.R. § 1.2110(b)(4); *see also* Ellis Thompson Corp., 10 FCC Rcd. 12,554, 12,555-56 (1994), in which the Commission identified the following factors used to determine control of a business: (1) use of facilities and equipment; (2) control of day-to-day operations; (3) control of policy decisions; (4) personnel responsibilities; (5) control of financial obligations; and (6) receipt of monies and profits; Intermountain Microwave, 12 FCC 2d. 559 (1963), and Application of Baker Creek Communications, LP, For Authority to Construct and Operate Local Multipoint Distribution Services in Multiple Basic Trading Areas, *Memorandum Opinion and Order*, 13 FCC Rcd. 18,709 (rel. September 23, 1998).

31. IN THE MATTER OF IMPLEMENTATION OF THE COMMERCIAL SPECTRUM ENHANCEMENT ACT AND MODERNIZATION OF THE COMMISSION'S COMPETITIVE BIDDING RULES AND PROCEEDURES, 21 F.C.C.R. 4753, 4763 WT Docket No. 05-211 (rel. April 25, 2006).

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TABLES

TABLE 1: CLOSED LICENSES WON BY ALASKA NATIVE

Market Name	Population	Net Bid	Price Per Pop
Bellingham, WA	127,780	$657,000	$5.14
Burlington, VT	369,128	$4,629,000	$12.54
Charlotte, NC	1,671,037	$73,402,000	$43.93
Cincinnati, OH	1,990,451	$56,201,000	$28.24
Cleveland, OH	2,894,133	$72,736,000	$25.13
Columbus, OH	1,477,891	$19,706,000	$13.33
Denver, CO	2,073,952	$64,298,000	$31.00
Gainesville, FL	260,538	$3,611,000	$13.86
Greensboro, NC	1,241,349	$40,647,000	$32.74
Jacksonville, FL	1,114,847	$23,880,000	$21.42
Joplin, MO	215,095	$481,000	$2.24
Lakeland, FL	405,382	$2,975,000	$7.34
Lansing, MI	489,698	$4,678,000	$9.55
Longview, WA	85,446	$289,000	$3.38
Los Angeles, CA	14,549,810	$435,205,000	$29.91
Melbourne, FL	398,978	$3,729,000	$9.35
Minneapolis, MN	2,840,561	$134,747,000	$47.44
New Haven, CT	978,311	$11,261,000	$11.51
New London, CT	357,482	$1,367,000	$3.82
New York, NY	18,050,615	$1,484,327,000	$82.23
Olympia, WA	258,937	$1,512,000	$5.84
Orlando, FL	1,256,429	$33,911,000	$26.99
Portland, ME	471,614	$4,802,000	$10.18
Portland, OR	1,690,930	$62,764,000	$37.12
Raleigh, NC	1,089,423	$56,902,000	$52.23
Sarasota, FL	513,348	$7,915,000	$15.42
Sarasota, FL	513,348	$7,746,000	$15.09
Tampa, FL	2,249,405	$73,042,000	$32.47
Worcester, MA	709,705	$4,383,000	$6.18
TOTAL	60,345,623	$2,691,803,000	

Source: FCC web site (http://www.fcc.gov/wtb/auctions/).

TABLE 2: CLOSED LICENSES WON BY ALASKA NATIVE

Market	Winning Bidder(s)	Net Bid ($M)	Last Bidder To Drop Out	Net Bid ($M)	Next to Last Bidder To Drop Out	Net Bid ($M)
Albany, NY	Leap/Northcoast	16.7	Alaska Native	16.6	Lafayette	16.5
Albuquerque, NM	Salmon PCS	31.1	Alaska Native	28.2	DCC PCS	13.2
Austin, TX	Leap/Cook Inlet	21.7	Alaska Native	20.7	Salmon PCS	19.7
El Paso, TX	Leap/Salmon PCS	15.5	Alaska Native	14.9	Salmon PCS	13.3
Grand Island, NE	Salmon PCS	1.2	Alaska Native	1.1	N.E. Colorado	0.8
Indianapolis, IN	Leap/Cook Inlet	26.6	Alaska Native	25.3	DCC PCS	19.4
Mt Pleasant, MI	Alpine PCS/Salmon	0.3	Alaska Native	0.3	NTCH	0.2
Providence, RI	Leap/Salmon PCS	19.8	Alaska Native	19.8	Cook Inlet	19.5
Rutland, VT	Northcoast	1.1	Alaska Native	1.0	Coloma	0.9
San Antonio, TX	Leap/DCC PCS	39.7	Alaska Native	39.7	Allegheny	36.8
Santa Fe, NM	Salmon PCS	3.1	Alaska Native	2.8	DCC PCS	1.6
Seattle, WA	Cook Inlet	102.5	Alaska Native	95.0	Connectbid	95.0
Syracuse, NY	DCC PCS	8.9	Alaska Native	8.4	3DL Wireless	7.5
Tucson, AZ	Salmon PCS	24.7	Alaska Native	22.3	DCC PCS	13.3
TOTAL		312.9		296.1		257.7

TABLE 3: MARKETS IN WHICH NORTHCOAST BID
BY ROUND OF FIRST BID

Market	Round of First Bid	Population	Market Tier	Winning Bidder
Albany, NY	1	1,028,615	Second	Yes
Atlantic City, NJ	13	319,416	Second	
Bloomington, IN	68	217,914	Second	
Boston, MA	1	4,133,895	First	
Burlington, VT	2	369,128	Second	
Cincinnati, OH	1	1,990,451	Second	Yes
Cleveland, OH	1	2,894,133	First	
Dayton, OH	1	1,207,689	Second	Yes
Elmira, NY	20	315,038	Second	
Evansville, IN	19	504,859	Second	
Fayetteville, NC	28	571,328	Second	
Glens Falls, NY	18	118,539	Second	Yes
Greensboro, NC	19	1,241,349	Second	
Indianapolis, IN	14	1,321,911	Second	
Ithaca, NY	18	94,097	Second	Yes
Keene, NH	18	111,709	Second	Yes
Louisville, KY	27	1,352,955	Second	
Manchester, NH	1	540,704	Second	Yes
New Haven, CT	14	978,311	Second	
New York, NY	1	18,050,615	First	
Oil City, PA	20	105,882	Second	
Olean, NY	14	239,343	Second	
Oneonta, NY	18	107,742	Second	Yes
Philadelphia, PA	1	5,899,345	First	
Pittsburgh, PA	18	2,507,839	First	
Plattsburgh, NY	14	123,121	Second	
Richmond, VA	19	1,090,869	Second	
Rutland, VT	2	97,987	Second	Yes
San Diego, CA	14	2,498,016	First	
Scranton, PA	2	678,410	Second	Yes
Sharon, PA	20	121,003	Second	
Utica, NY	18	316,633	Second	Yes
Mean Population	First Bid <=Round 14	3,100,866		
Mean Population	First Bid > Round 14	696,923		

TABLE 4: SUMMARY STATISTICS

Variable	Mean	Std. Dev	Min	Max
ATTQ	9.92×10^{8}	6.90×10^{8}	6.49×10^{8}	3.43×10^{9}
LogATTQ	20.58	0.464	20.29	21.96
Open-ATT	3.23×10^{9}	2.35×10^{9}	2.28×10^{8}	1.12×10^{10}
Price	3.27	1.25	0.10	4.18
PriceOpen	9.92×10^{8}	6.90×10^{8}	6.49×10^{8}	3.43×10^{9}